Modelling long term investments in wind energy – benefits of combining high resolution geo data, energy system modelling and auction design

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This paper addresses the link between geo data models, market design of renewable energy auctions and energy system models. Renewable energy accounts for around 20% of electricity supply in Europe. In countries such as Sweden, Finland and Germany we already reached a share of more than 40%. In these countries renewables became the main energy source. The dash for building renewable energy in Europe will continue with the EU and national climate targets.

The impact of renewables on the grid and system operation will increase. Key elements to build an efficient energy infrastructure in the long term are a good understanding on (1) how renewables will penetrate the energy system (regional investments) and a good perception on (2) the effects renewables have on the energy system including (3) the additional infrastructure required, enabling a secure electricity system.

Since 2005 the DLR uses geo data model ENDAT to predict wind power feed-in and investments in the years up to 2050 based on historic weather data. In order to allow for better modelling of the potentials of wind energy high resolution of wind data and efficient clustering methods are applied to allow a more detailed representation of the long term potentials of wind energy.

In this paper we combine three modelling approaches: The geo data model ENDAT (DLR), a model of the renewable auctions based on a system dynamics model HECTOR (RWTH Aachen) and an energy system model REMix (DLR) – that allows investigating the long term impact of renewables on the electricity system for 2030, 2040 and 2050. The key questions this paper aims to answer are: How will detailed spatial and temporal modelling of renewable energy data as well as auction design influence the predictions for future distribution of wind power plants? What policy recommendations can be drawn from predictions for the years up to 2050 with regard to policy design and investments in wind energy in Germany and Europe?

The paper divides in two parts. The first part investigates different approaches to model potential for wind power investments and power generation based on historic wind data. While in the past ENDAT used to generate time series for wind on a country by country basis or on NUTS-1 level, improved models allow for more detailed representation of wind data. Key element of this part is to understand the benefits of high resolution of wind data for the results of the overall energy system.
system modelling.

The second part of the paper describes how the detailed representation of wind potentials and wind speeds will affect future auction results - and therefore influence long term investments in renewable energy. Model results for the German electricity system will be presented. To benchmark different scenarios, each scenario will be evaluated based on the regional distribution of renewable energies and the resulting impact on the energy system (with regard to grid investments, operation costs and aspects of security of supply).